US009136212B2

(12) United States Patent
Kato

(10) Patent No.: US 9,136,212 B2
(45) Date of Patent: Sep. 15, 2015

(54) CIRCUIT BOARD

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: 13/247,031

(22) Filed: Sep. 28, 2011

(65) Prior Publication Data

US 2012/0012369 A1 Jan. 19, 2012

Related U.S. Application Data

(63) Continuation of application No. PCT/JP2010/051488, filed on Feb. 3, 2010.

(30) Foreign Application Priority Data

Apr. 2, 2009 (JP) 2009-089897

(51) Int. Cl.

H05K 1/00	(2006.01)
H01L 23/498	(2006.01)
H05K 1/02	(2006.01)
H05K 1/14	(2006.01)
H05K 1/16	(2006.01)
H05K 3/46	(2006.01)

(52) U.S. Cl.

CPC ***H01L 23/49822*** (2013.01); ***H05K 1/0271*** (2013.01); *H01L 2224/16225* (2013.01); *H01L 2224/16227* (2013.01); *H01L 2924/15311* (2013.01); *H05K 1/141* (2013.01); *H05K 1/16* (2013.01); *H05K 3/4632* (2013.01); *H05K 2201/0129* (2013.01); *H05K 2201/0352* (2013.01); *H05K 2201/09672* (2013.01); *H05K 2201/10674* (2013.01)

(58) Field of Classification Search

USPC 174/250, 252, 254–257, 260–264; 361/720, 728, 760, 794, 795; 438/238, 438/253, 393, 396, 660; 343/860; 428/209; 216/17; 29/830, 832, 852

See application file for complete search history.

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(57) ABSTRACT

A circuit board includes a laminated body including a laminate of a plurality of insulating-material layers made of a flexible material. External electrodes are provided on the top surface of the laminated body. An electronic component is mounted on the external electrodes. A plurality of internal conductors, when viewed in plan in the z-axis direction, are overlaid on the external electrodes and are not connected to one another in regions in which the internal conductors are overlaid on the external electrodes.

8 Claims, 9 Drawing Sheets

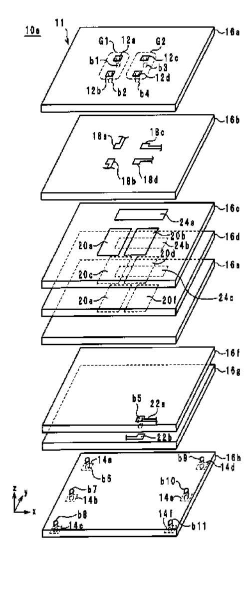

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FIG. 1

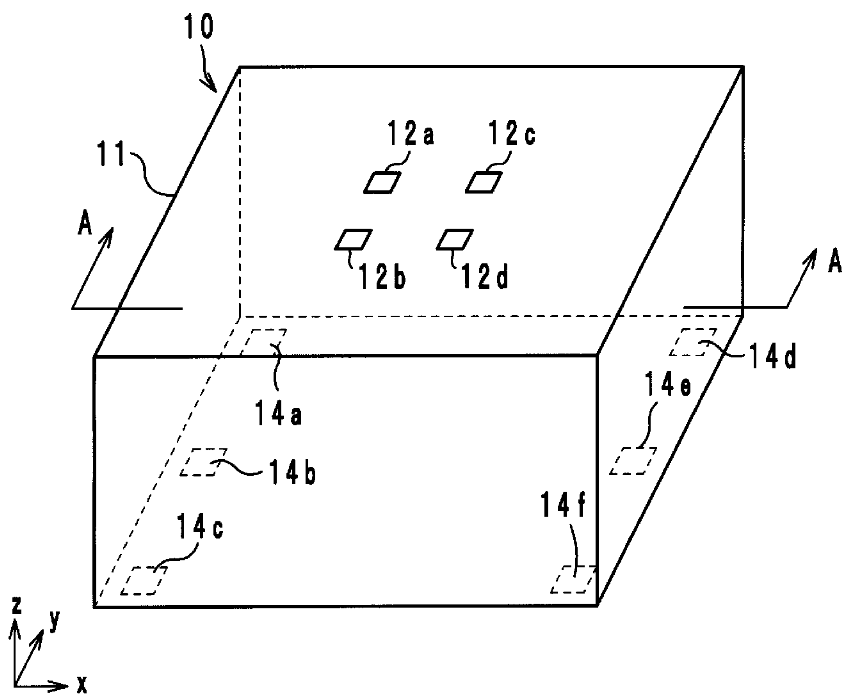
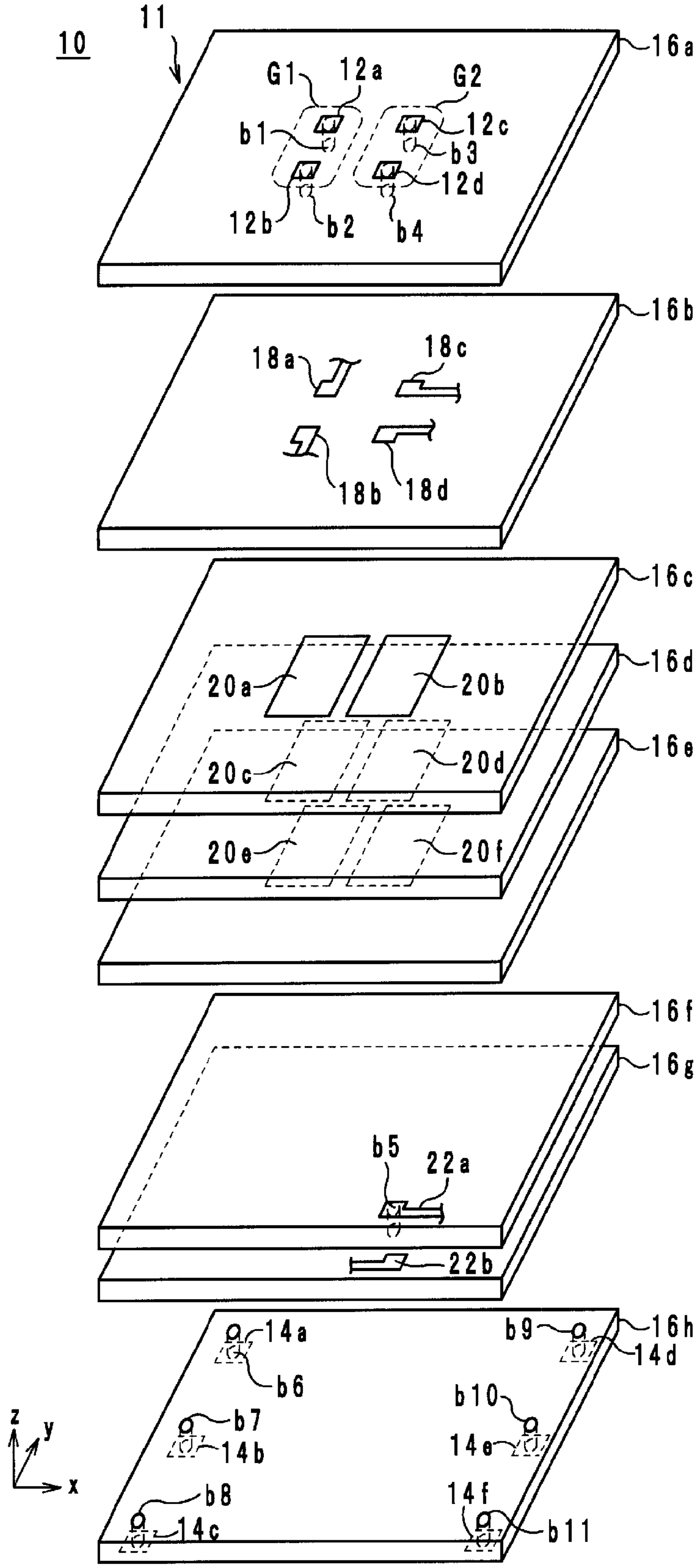


FIG. 2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G1
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G2
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b4
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18c
18b
18d
16c
16d
20a
20b
16e
20c
20d
20e
20f
16f
16g
b5
22a
22b
14a
b9
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b7
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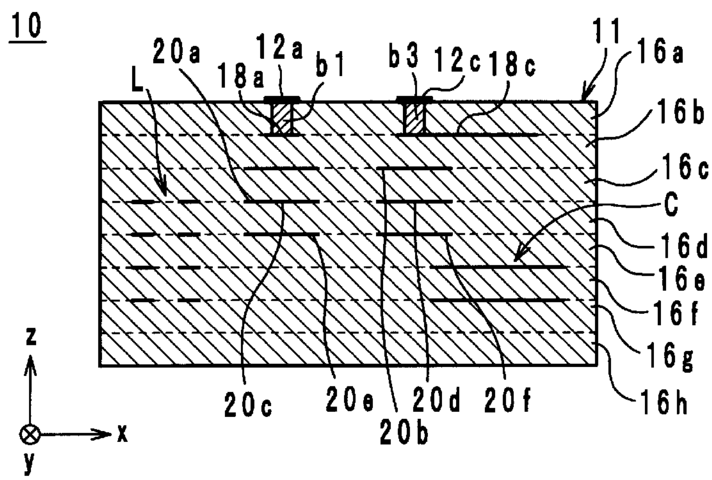
b8
14f
14c
b11

FIG. 3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b3
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11
16a
18a
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16h
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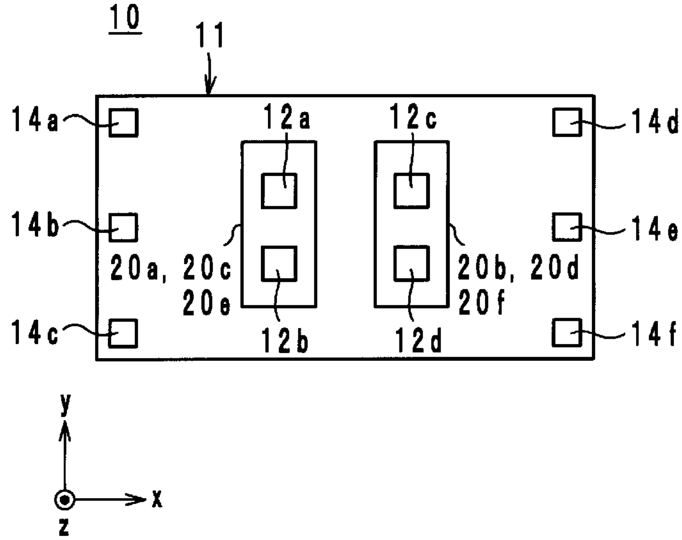
20e
20d
20f
20b
z
x
y

FIG. 4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12c
14d
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20f
14c
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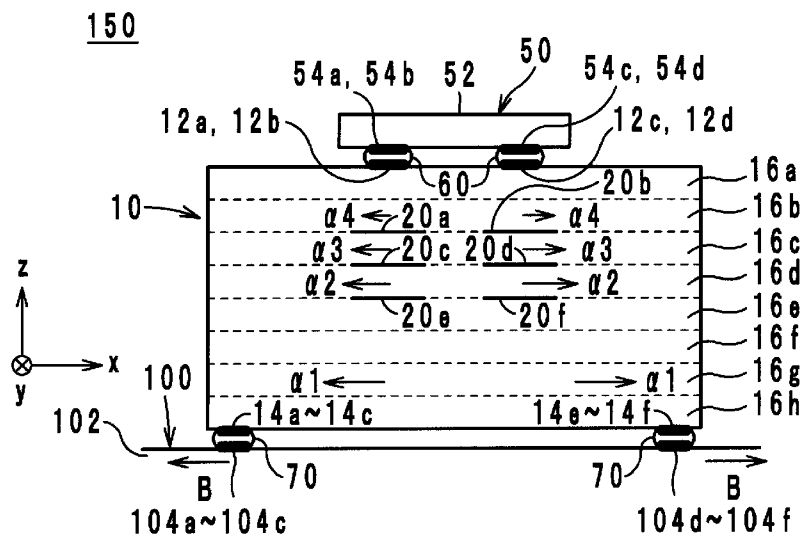
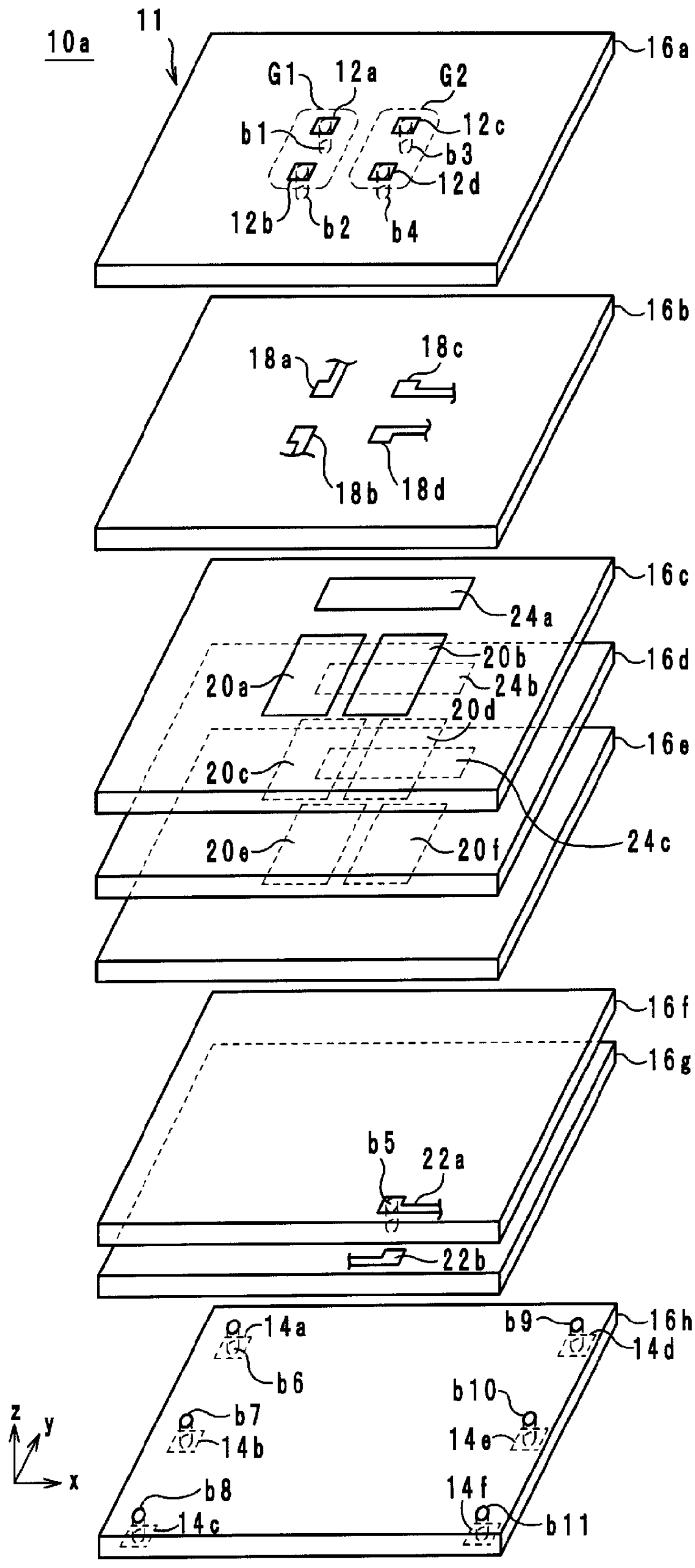
12d
14f
y
x
z

FIG. 5



150
50
54a, 54b
52
54c, 54d
12a, 12b
12c, 12d
60
20b
16a
10
α4
20a
α4
16b
α3
20c
20d
α3
16c
α2
α2
16d
20e
20f
16e
16f
z
x
y
100
α1
α1
16g
14a~14c
14e~14f
16h
102
B
70
70
B
104a~104c
104d~104f

FIG. 6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20c
24c
20e
20f
16f
16g
b5
22a
22b
b9
16h
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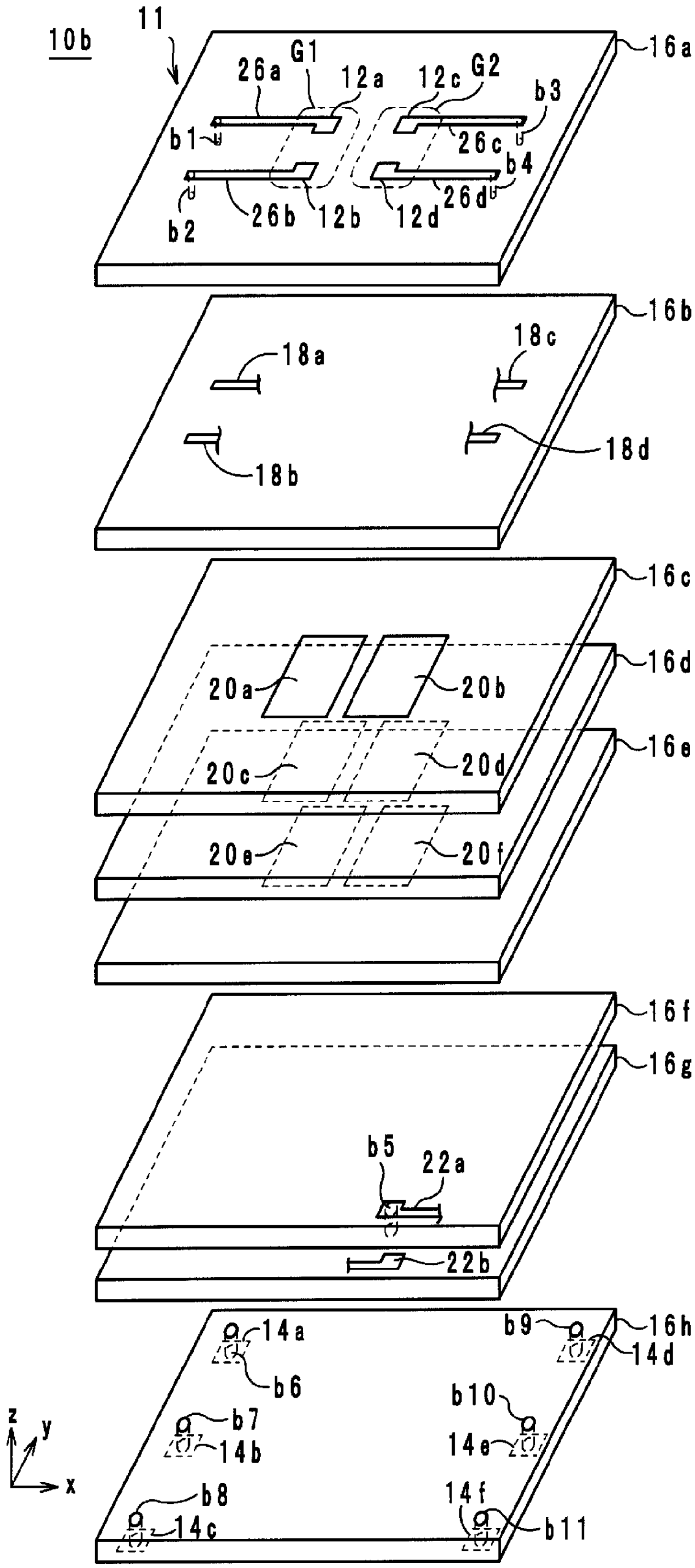
FIG. 7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16b
18a
18c
18d
18b
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16d
16e
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20b
20c
20d
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16f
16g
b5
22a
22b
16h
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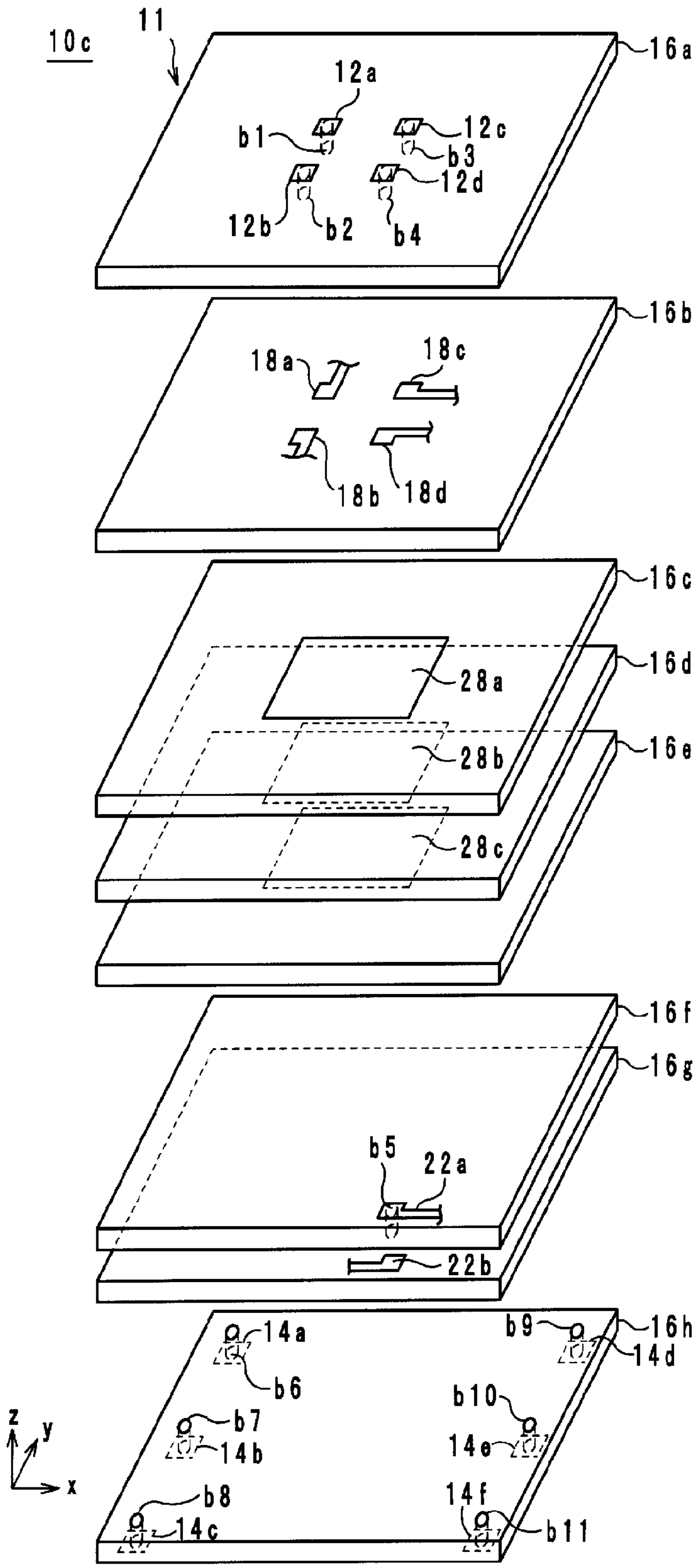
b8
14f
14c
b11
z
y
x

FIG. 8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12d
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b2
b4
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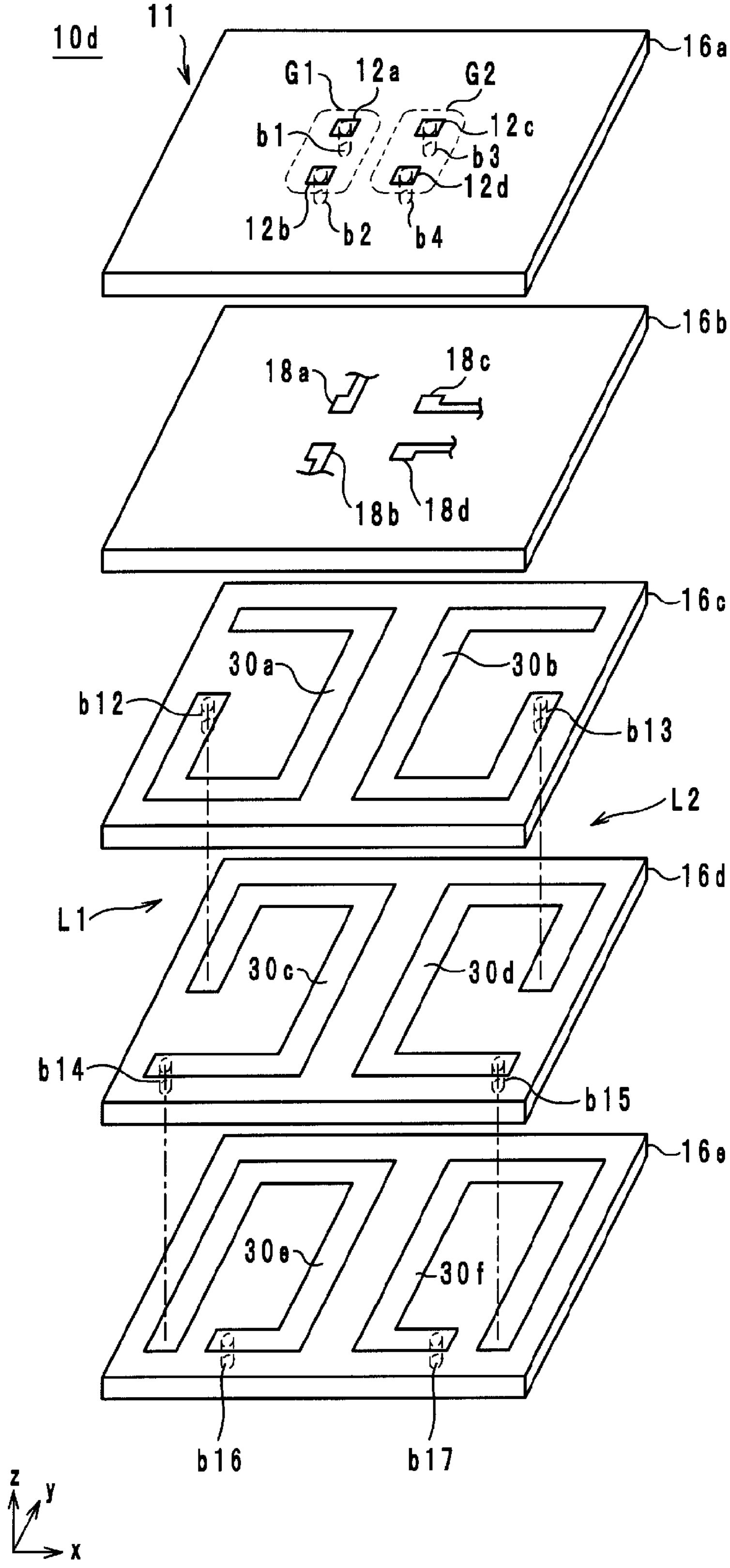
16d
28a
28b
16e
28c
16f
16g
b5
22a
22b
16h
14a
b9
14d
b6
b10
b7
14b
14e
z
y
x
b8
14f
14c
b11

FIG. 9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G1
12a
G2
12c
b1
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12d
12b
b2
b4
16b
18a
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18b
18d
16c
30a
30b
b12
b13
L2
16d
L1
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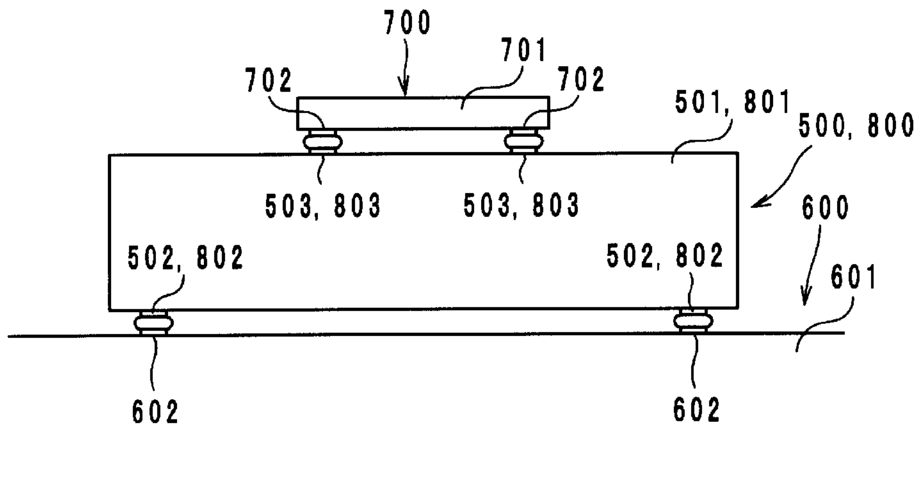
30d
b14
b15
16e
30e
30f
b16
b17
z
y
x

FIG. 10
PRIOR ART



CIRCUIT BOARD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to circuit boards, and more particularly, to a circuit board on which an electronic component is to be mounted.

2. Description of the Related Art

Circuit boards including laminates of ceramic layers are known as conventional general circuit boards. FIG. **10** is a diagram illustrating a conventional circuit board **500** mounted on a printed wiring board **600**. In addition, an electronic component **700** is mounted on the circuit board **500**. As illustrated in FIG. **10**, the circuit board **500** is composed of a main body **501** and external electrodes **502** and **503**. The main body **501** is composed of a laminate of ceramic layers and is a rigid board. The external electrodes **502** and **503** are provided on a top surface and a bottom surface, respectively, of the main body **501**.

The printed wiring board **600** is a motherboard mounted on, for example, an electronic device, such as a mobile phone, and is provided with a main body **601** and external electrodes **602**, as illustrated in FIG. **10**. The main board is a rigid board made of resin or the like. The external electrodes **602** are provided on a top surface of the main body **601**.

The electronic component **700** is, for example, a semiconductor integrated circuit and is provided with a main body **701** and external electrodes **702**. The main body **701** is a semiconductor board. The external electrodes **702** are provided on the bottom surface of the main body **701**.

As illustrated in FIG. **10**, the circuit board **500** is mounted on the printed wiring board **600**. Specifically, the circuit board **500** is mounted by connecting the external electrodes **502** to the external electrodes **602** by solder.

As illustrated in FIG. **10**, the electronic component **700** is mounted on the circuit board **500**. Specifically, the electronic component **700** is mounted by connecting the external electrodes **503** to the external electrodes **702** by solder. The circuit board **500**, the printed wiring board **600**, and the electronic component **700** described above are to be mounted in an electronic device, such as a mobile phone.

Meanwhile, the conventional circuit board **500** has a problem in that it is likely to be detached from the printed wiring board **600**. More specifically, it is likely that the printed wiring board **600** is bent by shock generated when the electronic component containing the circuit board **500** and the printed wiring board **600** is dropped. Even if the printed wiring board **600** is bent, the circuit board **500** may not be bent significantly along with the bending of the printed wiring board **600** since the circuit board **500** is a rigid board. Thus, stress is imposed on the solder connecting the external electrodes **502** to the external electrodes **602**. As a result, the solder is broken, and the circuit board **500** is detached from the printed wiring board **600**.

To overcome the above problem, the circuit board **500** may be fabricated by laminating sheets made of a flexible material. A printed circuit board disclosed in Japanese Unexamined Patent Application Publication No. 2006-93438, for example, includes a laminate of sheets made of a flexible material. FIG. **10** is used as a reference of a configuration of a printed board **800**.

The printed board **800** disclosed in Japanese Unexamined Patent Application Publication No. 2006-93438 includes a main body **801** and external electrodes (lands) **802** and **803**. The main body **801** is composed of a laminate of sheets made of thermoplastic resin. The external electrodes **802** and **803** are provided on the top surface and the bottom surface, respectively, of the main body **801**. Similarly to the circuit board **500**, the printed board **800** is mounted on the printed wiring board **600** through the external electrodes **802** on the bottom surface. Similarly to the circuit board **500**, the electronic component **700** is mounted on the printed board **800** through the external electrodes **803** on the top surface.

However, in the printed board **800** disclosed in Japanese Unexamined Patent Application Publication No. 2006-93438, the electronic component **700** is likely to be detached. Specifically, the printed board **800** can be bent since it is composed of sheets made of a flexible material. Thus, if the printed wiring board **600** is bent, the printed board **800** can be bent along with the bending of the printed wiring board **600**. Thus, it is possible to prevent the printed board **800** from being detached from the printed wiring board **600** due to breakage of solder connecting the external electrodes **602** and the external electrodes **802**.

Meanwhile, the printed board **800** has flexibility over its entire surface, and thus, the entire surface of the printed board **800** can be bent. On the other hand, the electronic component **700** is composed of a semiconductor board and, thus, cannot be bent significantly. Thus, stress is imposed on the external electrodes **702** and **803** and the solder connecting the external electrodes **702** and **803**. As a result, the solder may be broken, and the external electrodes **702** and **803** may be detached from the main bodies **701** and **801**. That is, the electronic component **700** and the printed board **800** may be disconnected.

In FIG. **10**, the printed board **800** is attached to the printed wiring board **600** through the external electrodes **802**. However, in a case in which the printed board **800** is attached to a casing by an adhesive or other material, the problem of possible disconnection between the electronic component **700** and the printed board **800** may also occur.

SUMMARY OF THE INVENTION

To overcome the problems described above, preferred embodiments of the present invention provide a circuit board which prevents an electronic component from being detached from the circuit board.

A circuit board according to a preferred embodiment of the present invention preferably includes a laminated body including a laminate of a plurality of insulating-material layers made of a flexible material, a first external electrode which is provided on a top surface of the laminated body and on which an electronic component is to be mounted, and a plurality of internal conductors which, when viewed in plan in a lamination direction, are overlaid on the first external electrode and are not connected to one another through via hole conductors in a region in which the internal conductors are overlaid on the first external electrode.

According to various preferred embodiments of the present invention, an electronic component is prevented from being detached from a circuit board.

The above and other elements, features, steps, characteristics, and advantages of the present invention will become more apparent from the following detailed description of the preferred embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an external perspective view of a circuit board according to a preferred embodiment of the present invention.

FIG. **2** is an exploded perspective view of the circuit board in FIG. **1**.

FIG. **3** is a cross-sectional structural view of the circuit board in FIG. **1** which is taken along line A-A.

FIG. **4** is a perspective view of the circuit board in FIG. **1** viewed in the lamination direction.

FIG. **5** is configuration diagram illustrating a module having the circuit board in FIG. **1**.

FIG. **6** is an exploded perspective view of a circuit board according to a first modified example of a preferred embodiment of the present invention.

FIG. **7** is an exploded perspective view of a circuit board according to a second modified example of a preferred embodiment of the present invention.

FIG. **8** is an exploded perspective view of a circuit board according to a third modified example of a preferred embodiment of the present invention.

FIG. **9** is an exploded perspective view of a circuit board according to a fourth modified example of a preferred embodiment of the present invention.

FIG. **10** is a diagram illustrating a conventional circuit board mounted on a printed wiring board.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the following, a circuit board according to preferred embodiments of the present invention will be described with reference to the drawings.

In the following, a configuration of a circuit board according to preferred embodiments of the present invention will be described with reference to the drawings. FIG. **1** is an external perspective view of a circuit board **10** according to a preferred embodiment of the present invention. FIG. **2** is an exploded perspective view of the circuit board **10** in FIG. **1**. FIG. **3** is a cross-sectional structural view of the circuit board **10** in FIG. **1** which is taken along line A-A. FIG. **4** is a perspective view from a lamination direction of the circuit board **10** in FIG. **1**. In FIGS. **1** to **4**, a lamination direction is defined as a direction in which insulating-material layers are laminated during fabrication of the circuit board **10**. The lamination direction is referred to as a z-axis direction. A direction along the long sides of the circuit board **10** is referred to as an x-axis direction, and a direction along the short sides of the circuit board **10** is referred to as a y-axis direction. Further, in the circuit board **10**, a surface at the forward side in the z-axis direction is referred to as a top surface, a surface at the rearward side in the z-axis direction is referred to as a bottom surface, and the other sides are referred to as side surfaces.

As illustrated in FIG. **1** and FIG. **2**, the circuit board **10** preferably includes a laminated body **11**, external electrodes **12***a* to **12***d* and **14***a* to **14***f*, internal conductors **18***a* to **18***d*, **20***a* to **20***f*, and **22***a* and **22***b*, and via hole conductors b**1** to b**11**. As illustrated in FIG. **2**, the laminated body **11** preferably includes a laminate of rectangular or substantially rectangular insulating-material layers **16***a* to **16***h* made of a flexible material, for example, a thermoplastic resign, such as liquid crystal polymer. Thus, the laminated body **11** has preferably a rectangular or substantially rectangular parallelepiped shape. Hereinafter, a front surface of the insulating-material layers **16** refers to a main surface at the forward side in the z-axis direction, and a back surface of the insulating-material layers **16** refers to a main surface at the backward side in the z-axis direction.

The external electrodes **12** are preferably layers made of a conductive material, for example, copper, and provided on the top surface of the laminated body **11**, as illustrated in FIG. **1**. More specifically, the external electrodes **12** are provided near the approximate center (the intersection point of diagonals) of the front surface of the insulating layer **16***a* which is provided at the forward-most side in the z-axis direction. The external electrodes **12***a* and **12***b* are arranged along the y-axis direction. The external electrodes **12***c* and **12***d* are arranged along the y-axis direction at positions closer to the forward side in the x-axis direction than positions of external electrodes **12***a* and **12***b*. Moreover, the external electrodes **12** are categorized into two groups (groups G**1** and G**2**). Specifically, the external electrodes **12***a* and **12***b* belong to the group G**1**. The external electrodes **12***c* and **12***d* belong to the group G**2**. The external electrodes **12** are arranged to be connected to an electronic component to be mounted on the top surface of the laminated body **11**.

The internal conductors **18***a* to **18***d* are preferably a wiring layer made of a conductive material, for example, copper, and disposed in the laminated body **11**, as illustrated in FIG. **2**. Specifically, the internal conductors **18** are provided on the front surface of the insulating-material layer **16***b*. The internal conductors **18***a* to **18***d* are overlaid on the external electrodes **12***a* to **12***d*, respectively, when viewed in plan in the z-axis direction. In FIG. **2**, only portions of the internal conductors **18** on which the external electrodes **12***a* to **12***d* are overlaid are shown, and illustration of the other portions is omitted.

The internal conductors **20***a* to **20***f* are preferably film-shaped conductors having relatively large areas, such as capacitor conductors and ground conductors, made of a conductive material, for example, copper, and are provided in the laminated body **11**. The internal conductors **20***a* to **20***f* are provided on a plurality of insulating-material layers **16**. Specifically, the internal conductors **20***a* and **20***b* are preferably arranged along the x-axis direction on the front surface of the insulating-material layer **16***c*. The internal conductors **20***c* and **20***d* are preferably arranged along the x-axis direction on the front surface of the insulating-material layer **16***d*. The internal conductors **20***e* and **20***f* are preferably arranged along the x-axis direction on the front surface of the insulating-material layer **16***e*.

Further, as illustrated in FIG. **4**, the internal conductors **20***a*, **20***c*, and **20***e* are preferably overlaid on one another so as to coincide with one another and also overlaid on the external electrodes **12***a* and **12***b* that belong to the group G**1** when viewed in plan in the z-axis direction. In this manner, the external electrodes **12***a* and **12***b* are overlaid on a plurality of internal conductors **20** when viewed in plan in the z-axis direction. In addition, when viewed in plan in the z-axis direction, the internal conductors **20***a*, **20***c*, and **20***e* are not connected to one another through via hole conductors in the regions where the internal conductors **20***a*, **20***c*, and **20***e* are overlaid on the external electrodes **12***a* and **12***b*.

The internal conductors **20***b*, **20***d*, and **20***f* are preferably overlaid on one another so as to coincide with one another and also overlaid on the external electrodes **12***c* and **12***d* that belong to the group G**2** when viewed in plan in the z-axis direction. In this manner the external electrodes **12***c* and **12***d* are overlaid on a plurality of internal conductors **20** when viewed in plan in the z-axis direction. When viewed in plan in the z-axis direction, the internal conductors **20***b*, **20***d*, and **20***f* are not connected to one another through via hole conductors in the regions in which the internal conductors **20***b*, **20***d*, and **20***f* are overlaid on the external electrodes.

The internal conductors **22** are preferably wiring layers made of a conductive material, for example, copper, and provided in the laminated body **11**, as illustrated in FIG. **2**. Specifically, the internal conductors **22***a* and **22***b* are provided on the front surfaces of the insulating-material layers **16***f* and **16***g*, respectively. In FIG. **2**, only portions around end portions of the internal conductors **22** are shown, and illustration of the other portions are omitted.

The external electrodes **14** preferably include a layer made of a conductive material, for example, copper, and provided on the bottom surface of the laminated body **11**. That is, the external electrodes **14** are provided on the back surface of the insulating-material layer **16**_h_ that is provided at the backward-most side in the z-axis direction. Further, the external electrodes **14**_a_ to **14**_c_ are arranged along the short side at the backward side in the x-axis direction on the bottom surface of the laminated body **11**. The external electrodes **14**_d_ to **14**_f_ are arranged along the short side at the forward side in the x-axis direction on the bottom surface of the laminated body **11**. In this manner, the external electrodes **12** and the external electrodes **14** are not overlaid on each other when viewed in plan view in the z-axis direction, as illustrated in FIG. **4**. The external electrodes **14** are arranged to be connected to a printed wiring board to be mounted on the bottom surface of the laminated body **11**.

As illustrated in FIG. **3**, the laminated body **11** preferably includes a coil (circuit element) L and a capacitor (circuit element) C. The coil L is preferably defined by internal conductors (omitted in FIG. **2**) and via hole conductors (not shown) which are provided on the front surfaces of the insulating-material layers **16**_d_ to **16**_g_. The capacitor C is preferably defined by internal conductors (omitted in FIG. **2**) provided on the front surfaces of the insulating-material layers **16**_f_ and **16**_g_. As illustrated in FIG. **3**, the internal conductors **20**_a_, **20**_c_, and **20**_e_ and the internal conductors **20**_b_, **20**_d_, and **20**_f_ are provided at positions upward from the center surface with respect to the z-axis direction.

The via hole conductors b**1** to b**11** connect the external electrodes **12** and **14**, the internal conductors **18**, **20**, and **22**, and the coil L and the capacitor C and are disposed so as to penetrate the insulating-material layers **16** in the z-axis direction. Specifically, as illustrated in FIG. **2**, the via hole conductors b**1** to b**4** penetrate the insulating-material layer **16**_a_ in the z-axis direction to connect the external electrodes **12**_a_ to **12**_d_ to the internal conductors **18**_a_ to **18**_d_, respectively.

The via hole conductor b**5** penetrates the insulating-material layer **16**_f_ in the z-axis direction and is not overlaid on the external electrodes **12** when viewed in plan in the z-axis direction, as illustrated in FIG. **2**. The via hole conductor b**5** connects the internal conductor **22**_a_ to the internal conductor **22**_b_. While FIG. **2** shows only the via hole conductor b**5** as a via hole connecting the internal conductors **22** to each other, a via hole conductor other than the via hole conductor b**5** to connect the internal conductors **22** to each other may also be present. However, any via hole conductor that connects the internal conductors **22** to each other is preferably not overlaid on the external electrodes **12**.

As illustrated in FIG. **2**, the via hole conductors b**6** to b**11** penetrate the insulating-material layer **16**_h_ in the z-axis direction and are not overlaid on the external electrodes **12** when viewed in plan in the z-axis direction. The via hole conductors b**6** to b**11** connect the internal conductors **22** provided on the insulating-material layers **16**_f_ and **16**_g_ to the external electrodes **14**_a_ to **14**_f_, respectively.

By laminating the insulating-material layers **16**_a_ to **16**_h_ configured as described above, the circuit board **10** illustrated in FIG. **1** is obtained.

FIG. **5** is a diagram illustrating a configuration of a module **150** including the circuit board **10**. The module **150** preferably includes the circuit board **10**, an electronic component **50**, and a printed wiring board **100**.

As illustrated in FIG. **5**, the electronic component **50** is preferably a device, such as a semiconductor integrated circuit, for example, mounted on the circuit board **10**. The electronic component **50** includes a main body **52** and external electrodes **54**_a_ to **54**_d_. The main body **52** is preferably a rigid board defined by, for example, a semiconductor substrate. The external electrodes **54** are provided on a main surface at the rearward side in the z-axis direction (bottom surface) of the main body **52**. The external electrodes **54**_a_ to **54**_d_ are preferably connected to the external electrodes **12**_a_ to **12**_d_, respectively, by solder **60**, for example. In this manner, the electronic component **50** is mounted on the top surface of the circuit board **10**.

The printed wiring board **100** preferably includes a main body **102** and external electrodes **104**_a_ to **104**_f_. The main body **102** is preferably a rigid board made of resin, for example. The external electrodes **104** are provided on a main surface at the forward side in the z-axis direction (top surface) of the main body **102**. The external electrodes **104**_a_ to **104**_f_ are connected to the external electrodes **14**_a_ to **14**_f_, respectively, preferably by a bonding agent, such as solder **70**. In this manner, the circuit board **10** is mounted on the printed wiring board **100** via the bottom surface. The module **150** described above is mounted on an electronic device such as a mobile phone.

In the following, a manufacturing method of the circuit board **10** will be described with reference to the drawings. First, the insulating-material layers **16** each of which including copper foil formed over the entirety or substantially the entirety of one of the main surfaces are prepared. In each of the insulating-material layers **16**_a_ to **16**_g_, the main surface on which the copper foil is formed is herein referred to as the front surface. On the other hand, in the insulating-material layer **16**_h_, the main surface on which the copper foil is formed is herein referred to as the back surface.

Then, the positions at which the via hole conductors b**1** to b**5** of the insulating-material layers **16**_a_ and **16**_f_ are to be formed (see, FIG. **2**) are irradiated with laser beams from the back surfaces, so that the via holes are formed. The positions at which the via hole conductor b**6** to b**11** of the insulating-material layer **16**_h_ are to be formed (see, FIG. **2**) are irradiated with laser beams from the front surface, so that the via holes are formed. In addition, via holes may also be formed in the insulating-material layers **16**_b_ to **16**_e_ and **16**_g_ as necessary.

In the following, the external electrodes **12** illustrated in FIG. **2** are preferably formed on the front surface of the insulating-material layer **16**_a_ by photolithographic processes, for example. Specifically, resists having the same shapes as the external electrodes **12** illustrated in FIG. **2** are printed on the copper foil of the insulating-material layer **16**_a_. Then, the copper foil is etched so that the copper foil on the portion which is not covered by the resists is removed. Then, the resist is removed. In this manner, the external electrodes **12** illustrated in FIG. **2** are formed on the front surface of the insulating-material layer **16**_a_.

Then, the internal conductors **18** illustrated in FIG. **2** are preferably formed on the front surface of the insulating-material layer **16**_b_ by photolithographic processes. The internal conductors **20** illustrated in FIG. **2** are formed on the front surfaces of the insulating-material layers **16**_c_ to **16**_e_ by photolithographic processes, for example. The internal conductors **22** illustrated in FIG. **2** are formed on the front surfaces of the insulating-material layers **16**_f_ and **16**_g_ by photolithographic processes. The internal electrodes defining the coil L and the capacitor C illustrated in FIG. **3** (not shown in FIG. **2**) are preferably formed on the front surfaces of the insulating-material layers **16**_d_ to **16**_g_ by photolithographic processes, for example. The external electrodes **14** illustrated in FIG. **2** are preferably formed on the back surface of the insulating-material layer **16***h* by photolithographic processes, for example. These photolithographic processes are similar to the photolithographic processes used when the external electrodes **12** are formed, and the description thereof will be omitted.

Then, the via holes formed in the insulating-material layers **16***a*, **16***f*, and **16***h* are filled with conductive paste preferably made primarily of copper, for example, so that the via hole conductors b**1** to b**11** are formed. If the via holes have been formed on the insulating-material layers **16***b* to **16***e* and **16***g*, these via holes are also filled with conductive paste.

Then, the insulating-material layers **16***a* to **16***h* are laminated in that order. By applying force to the insulating-material layers **16***a* to **16***h* from opposite directions in the lamination direction, the insulating-material layers **16***a* to **16***h* are press-bonded. In this manner, the circuit board **10** illustrated in FIG. **1** is obtained.

As will be described below, in the circuit board **10**, even if the shape of the printed wiring board **100** is changed, the circuit board **10** can be prevented from being detached from the printed wiring board **100**. More specifically, bending of the printed wiring board **600** may occur due to shock caused by dropping of an electronic device in which the conventional circuit board **500** and printed wiring board **600** are mounted. Since the circuit board **500** is a rigid board, in the case of bending of the printed wiring board **600**, the shape of the circuit board **500** may not be significantly changed in accordance with the bending of the printed wiring board **600**. Therefore, pressure is imposed on the solder connecting the external electrodes **502** and the external electrodes **602**. As a result, the solder may be broken, and the circuit board **500** may be detached from the printed wiring board **600**.

Thus, in the circuit board **10**, the laminated body **11** preferably includes a laminate of insulating-material layers **16** made of a flexible material. Therefore, the circuit board **10** can be bent more easily than the circuit board **500**. Therefore, even when the printed wiring board **100** is bent and the interval between the external electrodes **104** are changed due to dropping of an electronic device in which the module **150** illustrated in FIG. **5** is mounted, the intervals of the external electrodes **14** can also be changed by the deformation of the circuit board **10**. As a result, pressure on the solder connecting the external electrodes **14** and the external electrodes **104** is effectively reduced or prevented, which prevents the circuit board **10** from being detached from the printed wiring board **100**.

Further, in the circuit board **10**, the electronic component **50** is prevented from being detached from the circuit board **10**, as will be described below. More specifically, since the printed wiring board **800** disclosed in Japanese Unexamined Patent Application Publication No. 2006-93438 illustrated in FIG. **10** has flexibility over its entire surface, the entire printed wiring board **800** may be bent. Thus, the intervals between the external electrodes **803** may be changed. On the other hand, since the electronic component **700** includes a semiconductor substrate, the electronic component **803** cannot be significantly bent. Therefore, pressure is imposed on the external electrodes **702** and **803** and the solder connecting therebetween. As a result, the solder may be broken and the external electrodes **702** and **803** may be detached from the main bodies **701** and **801**. That is, the electronic component **700** and the printed wiring board **800** may be disconnected.

Accordingly, the circuit board **10** effectively prevents the electronic component **50** from being detached from the circuit board **10** by overlaying at least one of the internal conductors **18**, **20**, and **22** on the external electrodes **12** when viewed in plan in the z-axis direction. More specifically, when the printed wiring board **100** is bent in a convex manner, stresses are applied to the external electrodes **104** in directions indicated by arrows B, as illustrated in FIG. **5**. The external electrodes **104** are connected to the external electrodes **14** via the solder **70**. Further, the laminated body **11** has flexibility. Therefore, the external electrodes **14** receive stresses in the directions indicated by the arrows B in accordance with the displacement of the external electrodes **104**. As a result, tensile stresses α**1** are applied to the insulating-material layers **16***e* to **16***h* in the x-axis direction.

Note that the internal conductors **20** are preferably fabricated using metal foil, such as copper, for example, and the insulating-material layers **16** are preferably fabricated using thermoplastic resin, such as liquid crystal polymer, for example. Since the insulating-material layers **16** and the internal conductors **20** are simply press-bonded together, no chemical bonding is formed between the insulating-material layers **16** and the internal conductors **20**. Thus, the insulating-material layers **16** and the internal conductors **20** can be displaced with respect to each other. Therefore, when the tensile stresses are generated in the insulating-material layers **16***e* to **16***h*, the insulating-material layer **16***d* is displaced with respect to the internal conductors **20***e* and **20***f*. Similarly, the insulating-material layer **16***c* is displaced with respect to the internal conductors **20***c* and **20***d*. Similarly, the insulating-material layer **16***b* is displaced with respect to the internal conductors **20***a* and **20***b*.

As described above, when displacement between the insulating-material layers **16** and the internal conductors **20** occurs, a force is not transmitted from the insulating-material layers **16** provided at the backward side in the z-axis direction to the insulating-material layers **16** provided at the forward side in the z-axis direction. Thus, tensile stresses α**2** to α**4** generated in the insulating-material layers **16***d*, **16***c*, and **16***b* are less than the tensile stresses α**1** generated in the insulating-material layers **16***e* to **16***h*. More specifically, the magnitudes of the tensile stresses α**1** to α**4** progressively decrease in that order. Therefore, the tension in the x-axis direction generated in the insulating-material layers **16***a* to **16***h* progressively decreases in order from the backward side to the forward side in the z-axis direction. Accordingly, the external electrodes **12***a* and **12***b* provided on the front surface of the insulating-material layer **16***a* are not significantly displaced. As a result, the circuit board **10** prevents the electronic component **50** from being detached from the circuit board **10**. In addition, even when one of the main surfaces of an internal conductor and one of the main surfaces of an insulating-material layer is strongly bonded together by, for example, anchor effect, as in the case between the insulating-material layer **16***d* and the internal conductor **20***e* and between the insulating-material layer **16***c* and the internal conductor **20***c*, it is possible to cause displacement in the other main surface of the internal conductor to relax the stresses α if internal conductors are present on multiple layers.

In particular, in the circuit board **10**, a plurality of internal conductors **20** are overlaid on the external electrodes when viewed in plan in the z-axis direction. Thus, the tensile stresses generated in the insulating-material layers **16** are more effectively relaxed. As a result, the electronic component **50** is more effectively prevented from being detached from the circuit board **10**.

Further, in the circuit board **10**, when shock is applied on the printed wiring board **100** from the rearward side towards the forward side in the z-axis direction, the shock is prevented from being transmitted to the external electrodes **12**. More specifically, the via hole conductors are more rigid than the insulating-material layers **16** since the via hole conductors are made of a conductive material. Therefore, when the via hole conductors connecting the internal conductors **18**, **20**, and **22** are overlaid on the external electrodes **12** when viewed in plan in the z-axis direction, the shock may be transmitted from the external electrodes **12** through the via hole conductors.

Accordingly, in the circuit board **10**, the via hole conductor b**5** connecting the internal conductors **22** to each other is preferably not overlaid on the external electrodes **12** when viewed in plan in the z-axis direction, and the internal conductors **20** are not connected to one another in the region in which the internal conductors **20** are overlaid on the external electrodes **12**, when viewed in plan in the z-axis direction. That is, the external electrodes **12**, when viewed in plan in the z-axis direction, are preferably not overlaid on the via hole conductors other than the via hole conductors b**1** to b**4**. Therefore, when shock is applied to the printed wiring board **100**, the shock is not transmitted to the external electrodes **12** through the via hole conductors. As a result, when shock is applied to the printed wiring board **100** from the rearward side towards the forward side in the z-axis direction, the shock is prevented from being transmitted to the external electrodes **12**.

Further, in the circuit board **10**, when shock is applied to the printed wiring board **100** from the rearward side towards the forward side in the z-axis direction, the shock is prevented from being transmitted to the external electrodes **12** also for the reason described below. More specifically, shock from the printed wiring board **100** is transmitted to the laminated body **11** through the external electrodes **104**, the solder **70**, and the external electrodes **14**. Thus, it is preferable that the external electrodes **12** be disposed as far as possible from the external electrodes **14**. Accordingly, in the circuit board **10**, the external electrodes **12** are disposed so as not to be overlaid on the external electrodes **14** when viewed in plan in the z-axis direction. In this manner, when shock is applied to the printed wiring board **100** from the rearward side towards the forward side in the z-axis direction, the shock is prevented from being transmitted to the external electrodes **12**. To achieve the effects described above, it is preferable that the internal conductors be disposed as close as possible to the external electrodes **12**.

In the following, a circuit board **10***a* according to a first modified example of a preferred embodiment of the present invention will be described with reference to the drawing. FIG. **6** is an exploded perspective view of the circuit board **10***a* according to the first modified example.

The circuit board **10***a* is different from the circuit board **10** in that it preferably includes internal conductors (auxiliary conductors) **24***a* to **24***c*. More specifically, the internal conductor **24***a* is preferably provided on the front surface of the insulating-material layer **16***c* provided with the internal conductors **20***a* and **20***b*, along the direction in which the internal conductors **20***a* and **20***b* are arranged, i.e., the x-axis direction. Similarly, the internal conductor **24***b* is preferably provided on the front surface of the insulating-material layer **16***d* provided with the internal conductors **20***c* and **20***d*, along the direction in which the internal conductors **20***c* and **20***d* are arranged, i.e., x-axis direction. Similarly, the internal conductor **24***c* is preferably provided on the front surface of the insulating-material layer **16***e* provided with the internal conductors **20***e* and **20***f*, along the direction in which the internal conductors **20***e* and **20***f* are arranged, i.e., x-axis direction.

The internal conductors **24** provided as described above make it difficult for the insulating-material layers **16** to be stretched in the direction in which the internal conductors **20** are arranged (x-axis direction). As a result, even if the shape of the printed wiring board **100** is changed, the external electrodes **12***a* and **12***b* provided on the front surface of the insulating-material layer **16***a* are not significantly displaced. As a result, the circuit board **10***a* more effectively prevents the electronic component **50** from being detached from the circuit board **10***a*.

In the following, a circuit board **10***b* according to a second modified example of a preferred embodiment of the present invention will be described with reference to the drawing. FIG. **7** is an exploded perspective view of the circuit board **10***b* according to the second modified example.

The circuit board **10***b* is different from the circuit board **10** in that it preferably includes external conductors **26***a* to **26***d*. More specifically, the external conductors **26***a* to **26***d* are preferably connected to the external electrodes **12***a* to **12***d*, respectively. The via hole conductors b**1** to b**4** are preferably connected to the external conductors **26***a* to **26***d*, respectively. With this arrangement, the external electrodes **12***a* to **12***d* are not overlaid on the via hole conductor b**1** to b**4** when viewed in plan in the z-axis direction. As a result, when a shock is applied to the printed wiring board **100** from the rearward side towards the forward side in the z-axis direction, the shock is more effectively prevented from being transmitted to the external electrodes **12**.

In the following, a circuit board **10***c* according to a third modified example of a preferred embodiment of the present invention will be described with reference to the drawings. FIG. **8** is an exploded perspective view of the circuit board **10***c* according to the third modified example.

The circuit board **10***c* is different from the circuit board **10** in that internal conductors **28***a* to **28***c* are preferably provided in place of the internal conductors **20***a* to **20***f*. More specifically, the internal conductor **28***a* is preferably provided on the front surface of the insulating-material layer **16***c* and is overlaid on the external electrodes **12***a* to **12***d* when viewed in plan in the z-axis direction. Similarly, the internal conductor **28***b* is preferably provided on the front surface of the insulating-material layer **16***d* and is overlaid on the external electrodes **12***a* to **12***d* when viewed in plan in the z-axis direction. The internal conductor **28***c* is preferably provided on the front surface of the insulating-material layer **16***e* and is overlaid on the external electrodes **12***a* to **12***d* when viewed in plan in the z-axis direction. Similarly to the circuit board **10**, the circuit board **10***c* having the above configuration also prevents the electronic component **50** from being detached from the circuit board **10***c*.

In the following, a circuit board **10***d* according to a fourth modified example of a preferred embodiment of the present invention will be described with reference to the drawings. FIG. **9** is an exploded perspective view of the circuit board **10***d* according to the fourth modified example. FIG. **9** illustrates the insulating-material layers **16***a* to **16***e*. The insulating-material layers **16***f* to **16***h* of the circuit board **10***d* are the same or substantially the same as the insulating-material layers **16***f* to **16***h* of the circuit board **10** illustrated in FIG. **2**, and the description thereof will be omitted.

The circuit board **10***d* is different from the circuit board **10** in that it is preferably provided with internal conductors **30***a* to **30***f* and via hole conductors b**12** to b**17** in place of the internal conductors **20***a* to **20***f*. More specifically, the internal conductors **30***a* and **30***b* are preferably provided on the front surface of the insulating-material layer **16***c* to define a ⅞-turn coil conductor. Further, the internal conductor **30***a* is overlaid on the external electrodes **12***a* and **12***b* when viewed in plan in the z-axis direction. The internal conductor **30***b* is overlaid on the external electrodes **12***c* and **12***d* when viewed in plan in the z-axis direction. The internal conductors **30***c* and **30***d* are preferably provided on the front surface of the insulating-material layer **16***d* to define a ⅞ coil conductor. Further, the internal conductor **30***c* is overlaid on the external electrodes **12***a* and **12***b* when viewed in plan in the z-axis direction. The internal conductor **30***d* is overlaid on the external electrodes **12***c* and **12***d* when viewed in plan in the z-axis direction. The internal conductors **30***e* and **30***f* are preferably provided on the front surface of the insulating-material layer **16***e* to define a ⅞ coil conductor. Further, the internal conductor **30***e* is overlaid on the external electrodes **12***a* and **12***b* when viewed in plan in the z-axis direction. The internal conductor **30***f* is overlaid on the external electrodes **12***c* and **12***d* when viewed in plan in the z-axis direction.

Each of the via hole conductors b**12** and b**13** preferably penetrates the insulating-material layer **16***c* in the z-axis direction to connect ends of the internal conductors **30***a* and **30***b* to ends of the internal conductors **30***c* and **30***d*. Similarly, each of the via hole conductors b**14** and b**15** preferably penetrates the insulating-material layer **16***d* to connect ends of the internal conductors **30***c* and **30***d* to ends of the internal conductors **30***e* and **30***f*. Each of the via hole conductors b**16** and b**17** preferably penetrates the insulating-material layer **16***e* and are connected to ends of the internal conductors **30***e* and **30***f*. In this manner, the internal conductors **30***a*, **30***c*, and **30***e* and the via hole conductors b**12**, b**14**, and b**16** define a coil L**1**. The internal conductors **30***b*, **30***d*, and **30***f* and the via hole conductors b**13**, b**15**, and b**17** define a coil L**2**.

As described above, similarly to the circuit board **10**, by using the internal conductors **30**, which define coil conductors, instead of the internal conductors **20**, which define capacitor conductors or ground conductors, detachment of the electronic component **50** from the circuit board **10***d* is effectively prevented. While the internal conductors **30** preferably define coil conductors, the internal conductors **30** may be simple wiring conductors which do not define coils.

In the circuit boards **10** and **10***a* to **10***d*, the external electrodes **14** are preferably provided on the bottom surface of the laminated body **11**. However, the external electrodes **14** may be provided on a side surface.

In the circuit boards **10** and **10***a* to **10***d*, the external electrodes **14** are not necessarily provided. Specifically, each of the circuit boards **10** and **10***a* to **10***d* may be bonded on a casing instead of being mounted on the printed wiring board **100**. In this case, the external electrodes **14** are not necessary in the circuit boards **10** and **10***a* to **10***d*.

Preferred embodiments of the present invention are practicable in a circuit board. In particular, preferred embodiments of the present invention are advantageous to effectively prevent an electronic component from being detached from a circuit board.

While preferred embodiments of the present invention have been described above, it is to be understood that variations and modifications will be apparent to those skilled in the art without departing from the scope and spirit of the present invention. The scope of the present invention, therefore, is to be determined solely by the following claims.

What is claimed is:

1. A circuit board comprising:

a flexible laminated body including a laminate of a plurality of insulating-material layers made of a flexible material, a first external electrode provided on a top surface of the flexible laminated body and on which an electronic component is to be mounted; and

a plurality of film-shaped conductors each of which, when viewed in plan in a lamination direction of the flexible laminated body, is provided on a respective insulating-material layer of the plurality of insulating-material layers; wherein

an area of each of the plurality of film-shaped conductors is larger than an area of the first external electrode, and the entire first external electrode, when viewed in plan in the lamination direction of the flexible laminated body, is overlapped with the plurality of film-shaped conductors;

the plurality of film-shaped conductors, when viewed in plan in a lamination direction of the laminated body, are not connected to one another through via hole conductors in regions in which the plurality of film-shaped conductors are overlapped with the first external electrode; and

when the flexible laminated body is bent, the film-shaped conductor is displaced by a greater amount than an amount by which the first external electrode is displaced; and

each of the plurality of film-shaped conductors is provided in an area of the respective insulating-material layer under the first external electrode and is spaced away from all edges of the respective insulating-material layer.

2. The circuit board according to claim **1**, wherein at least one of the film-shaped conductors is provided closer to the top surface of the flexible laminated body than a central area of the flexible laminated body in the lamination direction of the flexible laminated body.

3. The circuit board according to claim **1**, further comprising:

a second external electrode provided on a bottom surface or a side surface of the flexible laminated body; and

a via hole conductor connected to the second external electrode which is not overlaid on the first external electrode when viewed in plan in the lamination direction of the flexible laminated body.

4. The circuit board according to claim **3**, wherein

the second external electrode is arranged to be connected to a wiring board to be mounted on the bottom surface.

5. The circuit board according to claim **3**, wherein the second external electrode is not overlaid on the first external electrode when viewed in plan in the lamination direction of the flexible laminated body.

6. The circuit board according to claim **1**, wherein

a plurality of the first external electrodes are provided and divided into a first group and a second group;

the first external electrodes that belong to the first group are overlaid on a first film-shaped conductor among the plurality of film-shaped conductors when viewed in plan in the lamination direction of the flexible laminated body; and

the first external electrodes that belong to the second group are overlaid on a second film-shaped conductor among the plurality of film shaped conductors when viewed in plan in the lamination direction of the flexible laminated body, the second film-shaped conductor being provided on the same one of the plurality of insulating-material layers as the first film-shaped conductor.

7. The circuit board according to claim **6**, further comprising an auxiliary conductor provided on the same one of the plurality of insulating-material layers on which the first film-shaped conductor and the second film-shaped conductor are provided, along a direction in which the first film-shaped conductor and the second film-shaped conductor are arranged.

8. The circuit board according to claim 7, wherein

at least two of the first film-shaped conductors and at least two of the second film-shaped conductor are provided;

the at least two first film-shaped conductors and the at least two second film-shaped conductors are provided on at least two of the plurality of insulating-material layers; and

the auxiliary conductor is provided on each of the at least two of the plurality of insulating-material layers on which the first film-shaped conductors and the second film-shaped conductors are provided.

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